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ABSTRACT

Sixty high school juniors and seniors participated in an experiment testing the effects of learning strategies on performance. The experiment was run in two identical sessions except for the type of test administered. Information on classifying six types of sailboats was presented through slides and an oral explanation. Subjects were then given a brief study period in which they: (1) studied an experimenter-generated matrix which organized the sailboat information; (2) completed a matrix in which only headings were given; or (3) used a blank sheet of paper for study as they chose. Following the study period, the 30 students in the first session were given a classification test, and those in the second, a recall test. Subjects then filled out a questionnaire asking what type of learning strategies they had used. A strategies x test-type factorial analysis revealed a significant main effect for strategies, and a significant interaction, supporting the hypothesis that conscious cognitive activities are important in the learning process, and that outcome demands influence strategy choice. A second experiment for validation of the questionnaire obtained an alpha reliability coefficient of .76. A factor analysis establishing construct validity indicated overt strategies, clustering strategies, and mnemonic strategies were the factors underlying the data. (Author/CM)

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Effects of Study Strategies on Outcome in Recall and Classification Tests

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Abstract

Sixty high school juniors and seniors participated in an experiment designed to test the effects of learning strategies on performance. The experiment was run in two sessions in which procedures were identical except for the type of test administered. Information on classifying six different types of sailboats was presented by means of slides accompanied by an oral explanation. After presentation of the experimental materials, subjects were given a brief study period in which they; (1) studied an experimenter-generated matrix which organized the information on sailboats; (2) filled out a matrix in which only headings were given; or (3) used a blank sheet of paper for study in any way they chose. Following the study period, the 30 students in the first session were given a classification test, and those in the second session were given a recall test. After the testing procedure, subjects filled out a questionnaire asking what type of learning strategies they had used. A strategies x test-type factorial analysis revealed a significant main effect ($p < .001$) for strategies, and a significant ($p < .001$) interaction. These results support the hypothesis that the conscious cognitive activities of students are important in the learning process, and also that outcome demands influence strategy choice. A second experiment with another sample of 60 students was performed for the purpose of obtaining additional data for validation of the questionnaire. From these data, an alpha reliability coefficient of .76 was obtained. A factor analysis performed for the purpose of establishing construct validity indicated three factors underlying the data: overt strategies, clustering strategies, and mnemonic strategies.

Effects of Study Strategies on

Outcome in Recall and Classification Tests

Research on instruction during the past decade has been primarily concerned with optimizing the richness and quality of scientifically designed instructional packages (Merrill, Kowallis, & Wilson, 1981), and with the outcomes obtained from such presentation displays. More recently, the role of the learner in interacting with instruction has become an important concern for instructional researchers. Wittrock (1979) puts it this way: "A cognitive approach implies that learning is scientifically more productively studied as an internally, cognitively mediated process than as a direct product of the environment, people, or factors external to the learner" (p. 5). A cognitive approach, then, means that attempts to optimize the design of instructional materials without also considering how such materials are processed by students is getting at only part of the traching/learning process. Bobrow and Norman (1975) postulate that stimulus materials ("data-driven") set into motion a parallel set of cognitive processes ("response-driven") which are important for learning to occur.

Recent research in cognitive psychology suggests a number of reasons for investigating the cognitive correlates of instruction. Rigney (1978) concluded that merely giving "learn" instructions does not necessarily enhance learning. He suggested that it is possible to facilitate learning outcomes by encouraging students to gain better control over the kinds of information processing they do while acquiring, retaining, and retrieving information. Although cognitive activities carried out by learners have been studied by a number of previous investigators (e.g., Dansereau, 1978; Rigney, 1978; Weinstein, 1978), no systematic study of their role in instruction has been carried out.

Much of the earlier work focused on strategies embedded in instruction.

Rothkopf and Bisbicos (1967) demonstrated that learning was facilitated by adjunct questions which directed attention to main ideas contained in text. Merrill and his associates (Merrill, Olsen, & Coldeway, 1976; Wilcox, McLachlan, & Merrill, 1978; Wilcox, Richards, Merrill, & Hindmarsh, 1979) investigated the effects of such cuing devices as color, underlining, bold letters, and isolated summaries in focusing attention on important conceptual information. They found that such attention-directing devices had a beneficial effect on learning.

Studies which focused on internal cognitive processes rather than on embedded devices include those on the use of imagery as a learning strategy (Anderson & Hidde, 1971; Paivio, 1971, 1974; Rasco, Tennyson, & Boutwell, 1975; Steingart & Glock, 1979). Other investigators have focused on the use of mnemonic strategies (Higbee, 1979; Raugh & Atkinson, 1975). Performance increments have also been demonstrated when students have been directed to state materials in their own words (Delgiorno, Jenkins, & Bauswell, 1974), and when they have been directed to reorganize the incoming information (DiVesta, Schultz, & Dangel, 1973; Frase, 1973). It should be noted that many of the studies cited used serial and paired-associate word lists rather than more realistic instructional materials.

Merrill (1980) has suggested that it is important to consider not only the conscious cognitive activities of the learner, but also presentation display variables and outcome task demands. The present study represents an attempt to investigate learning strategies as they relate to treatment variables and desired outcome behaviors. Suggested study strategies were varied along three dimensions, and the outcome task required either recall or classification behavior.

It was hypothesized that both experimenter- and student-generated matrices which aided in organizing information would prove to be more effective study

strategies than student-chosen strategies, and that subjects using the experimenter-generated matrix would perform highest overall. It was further hypothesized that some learning strategies, as measured by a posttest questionnaire, would be more frequently used for recall items and others would be more frequently used for classification items.

Experiment 1

Method

Subjects. Sixty eleventh and twelfth grade students enrolled in an alternative high school in California participated in the study. One-hundred students were randomly selected from a list of the 277 11th and 12th graders at the school to form a subject pool for the experiment. The experiment was run in two sessions on the same day, with 30 students in each session, morning and afternoon. Because of attrition due to absences and the fact that some students selected did not wish to participate in the experiment, it was necessary to supplement each group with non-randomly selected subjects. Nine such subjects were added to the morning group, and 18 were added to the afternoon group.

Apparatus and materials. The experimental task was an adaptation of a design developed by Maurice Coleman. During the presentation phase, subjects viewed 75 slides, presented by means of a Kodak Ektagraphic Model AF2 slide projector. The slides were accompanied by oral explanations read by the experimenter from a script. The audiovisual presentation gave subjects information important in classifying six different types of sailboats.

Study materials which followed the presentation phase were of three types: (1) and experimenter-generated matrix which was completely filled in with relevant information; (2) a subject-generated matrix which consisted of

headings only; and (3) a blank page with instructions to subjects to utilize the space and/or time for any type of study and review they chose.

Test materials which were presented following the study phase were of two types. A paper-and-pencil test consisting of 18 cued-recall items required one-word responses. A classification test required subjects to identify six different types of sailboats presented randomly on 18 slides. Subject responses for both tests were written on prepared answer sheets.

A posttest questionnaire contained 25 items which asked subjects to identify learning/study strategies they had used in trying to learn the information presented. The questionnaire items were based on those in a study-strategies questionnaire used by Weinstein (1978) and her associates (Schulte & Weinstein, Note 1) in their work.

Procedure

The experiment was run in two sessions with 30 subjects participating in each session. Procedures were the same for each session, except that the morning group was given a classification test and the afternoon group was given a recall test. After the subjects were assembled in the experimental room, they were given a general explanation of the project, its purposes, and procedures which were to be followed. They were informed that a posttest questionnaire asking about study strategies was an important part of the experiment and were requested to think about what strategies they were using during the learning/study phases. At this time the experimenter answered any questions the subjects had about the project.

After the introductory period, student packets, which had been randomly ordered, were distributed. The experimental slides with accompanying dialogue were then presented, after which the subjects were given a 10-minute study

period in which they were asked to utilize the three different study treatments described above. After the study phase, the morning group was given a classification test with audioslides as stimuli. Slides were presented at 15 second intervals with dialogue presented by the experimenter. The afternoon group was given a paper-and-pencil recall test. Following the tests, each group was asked to complete the posttest questionnaire.

The entire experimental procedure took about 45 minutes for each group.

Results

Data from the experiment were analyzed in three different ways to test the hypotheses of interest. Analyses utilized formulas and procedures from Glass and Stanley (1970) and from Kirk (1968). To test the effects of treatments on achievement, one-way analyses of variance were run on the classification and recall groups, with posttest scores as the outcome variable. Data from these analyses are shown in Tables 1 and 2.

Table 1

Posttest Means (Standard Deviations in Parentheses)

Recall (Total Score = 18)	
Experimenter Matrix	14.30 (2.75)
Subject Matrix	11.63 (4.24)
Control	10.83 (2.44)

Classification (Total Score = 18)	
Experimenter Matrix	8.70 (4.00)
Subject Matrix	9.83 (3.38)
Control	9.00 (3.16)

Table 2

ANOVA Tables

Source	df	MS	F	
Recall (N = 30)				
Between groups	2	34.58	3.59	$p < .05$
Within groups	27	9.62		
Classification (N = 30)				
Between groups	2	3.80	.04	n/s
Within groups	27	95.01		

A comparison between means using the Scheffé method revealed that on the recall test, the mean of the group using the experimenter-generated matrix differed significantly from the mean of the control group ($p < .005$). None of the other comparisons were significant.

A second analysis was a 3(treatment: experimenter-generated matrix, subject-generated matrix, control) x 2(test type: recall, classification) factorial analysis of variance. The outcome variable of interest was test type. This analysis revealed a significant test type main effect ($p < .001$), indicating that subjects in the recall group ($\bar{X} = 12.2$, $S = 3.37$) performed significantly better than those in the classification group ($\bar{X} = 9.23$, $S = 3.46$). A Scheffé comparison of means again indicated a significant difference between the experimenter-generated matrix group and the control group ($p < .05$). Table 3 presents the ANOVA table for the factorial analysis.

It was postulated that the strategy-use questionnaire measured several different types of cognitive strategies. For this reason, data were logically grouped into seven categories: (1) rehearsal, (2) covert practice, (3) imaging/

pictorial, (4) mnemonic, (5) main ideas, (6) analogy/personal experience, and (7) organizing information. Some of the items were included in more than one category. These data were analyzed by means of a 2(test type: recall, classification) x 7(strategy) factorial analysis of variance with strategy use as the outcome variable. Results of the analysis are shown in Tables 4 and 5. Both a main effect for strategy and a strategy x test type interaction were significant at the .001 level.

Table 3

Treatment x Test Type ANOVA

Source	df	MS	F	
Treatment	2	1.26	1.17	n/s
Test type	1	14.20	13.15	$p < .001$
Treatment x test type	2	2.39	2.21	n/s
Within cells	54	1.08		

Table 4

Cell Means - Strategies (Standard Deviations in Parentheses)

	Recall	Classification
1.	.51 (.50)	.42 (.50)
2.	.43 (.50)	.38 (.49)
3.	.35 (.48)	.43 (.50)
4.	.24 (.43)	.20 (.40)
5.	.39 (.49)	.31 (.18)
6.	.24 (.43)	.18 (.38)
7.	.14 (.35)	.14 (.35)

Table 5

Test Type x Strategy ANOVA

Source	df	MS	F	
Test type	1	0.16	.80	n/s
Strategy	6	3.23	16.15	$p < .001$
Test type x strategy	6	1.96	9.8	$p < .001$
Within cells	1666	.20		

Kirk (1968) has suggested that when a significant interaction is found, post hoc comparisons of simple main effects should be performed. These comparisons were made, with the following results. Rehearsal, covert practice, mnemonic strategies, and main ideas were used significantly more frequently by subjects who took the recall test. All comparisons were significant at the .001 level. Only imaging/pictorial strategies were reliably used more frequently by subjects who took the classification test ($p < .001$). There were no between groups differences in the use of analogy/personal experience and organizing information strategies. The disordinal interaction is shown graphically in Figure 1.

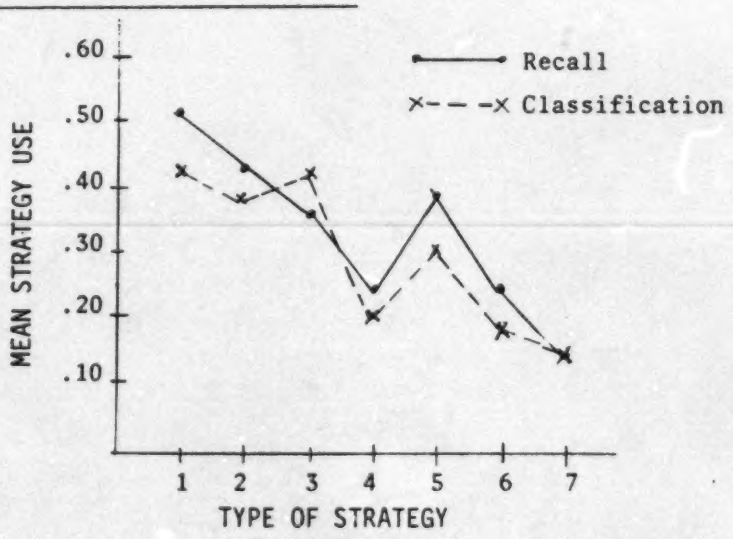

Figure 1. Test type x strategy interaction.

Discussion

The hypothesis that subjects using the experimenter-generated matrix would perform highest overall was supported by the data. Although mean scores of the recall group were in the predicted direction, subjects using the subject-generated matrix did not exhibit significantly higher scores than controls. Thus the hypothesis that subjects in both the experimenter-matrix and subject-matrix groups would outperform controls was not supported. Results from the classification group were especially puzzling. Contrary to expectation, there were no reliable differences among treatment groups; mean scores were remarkably similar. It had been expected that a matrix study treatment would be especially helpful for subjects who were required to classify instances of the six different sailboats. The fact that test performance on the recall test was significantly better than that on the classification test was not unexpected, since rote memorization of facts represents a lower order cognitive skill than the ability to classify objects into categories (cf. Bloom's 1956 taxonomy).

Of more interest in terms of questions about learner strategies are the results from the analyses of study strategies used, as reported by subjects in the posttest questionnaire. The disordinal interaction, however, makes interpretation of the results more difficult. As Lubin (1961) points out, when the interaction is disordinal, it is nearly impossible to make statements about main effects. Lubin further suggests that a significant interaction raises two important questions: "How does this interaction occur? How can I bring it under experimental control?" (p. 816).

The simple main effects analyses tell us which strategies were used more frequently by subjects in each of the two test groups, and thus gives us a descriptive picture of strategy use by students. These analyses, however, do

not tell us which strategies were more effective in terms of performance on the two types of outcome tests. Further investigations are being planned which will examine this important question.

The significant strategy x test type interaction and the results of the simple main effects analyses do, however, support the hypothesis that students use different types of cognitive strategies when faced with different test situations, as postulated by Bransford, Nitsch, and Franks (1977). Although this question was not studied specifically, results from a number of other investigations (Kavale & Schreiner, 1979; Matthews, Hunt, & McLeod, 1980; Stein, 1978) also support this hypothesis.

Experiment 2

Method and Procedure

The second experiment was a replication of Experiment 1 with different subjects from the same suburban high school in Orange County, California. All details of the experiment were the same, except that no attempt was made to randomly select subjects because of the difficulties to do so encountered in Experiment 1. Experimental materials, however, were again randomly ordered. The primary purpose of the experiment was to gather additional data in an attempt to establish reliability and validity for the instrument measuring use of cognitive strategies. Outcome performance test data have not been analyzed.

Results

Questionnaire data from both Experiment 1 and Experiment 2 were combined and analyzed. From part of this analysis, an alpha reliability coefficient of .76 was obtained. Factor analytic procedures were used in an attempt to reduce the data from the 25 items to a smaller number of factors and also to establish construct validity (Kerlinger, 1973). A principal factors varimax rotation

procedure used the SPSS computer program (Nie, Hull, Jenkins, Steinbrenner, & Bent, 1975). The initial rotation produced nine factors, two of which were specific factors.

Inspection of eigenvalues indicated trying three, four, and five rotation solutions. The three-factor rotation seemed to provide the best theoretical and mathematical fit to the data. It was also the only solution which did not include at least one specific factor. Additionally, the three-factor solution conformed well to Thurstone's five principles of simple structure (reported in Kerlinger, 1973). Table 6 shows factor loadings and communalities for all 25 questionnaire items.

Discussion

Examination of the factor loadings in Table 6 indicates that items 20, 1, and 13 should be dropped from future analyses. In addition to having low loadings, these items did not seem to "fit"with other items in the factor clusters. Factor analytic procedures produced fewer factors than those selected logically for statistical analyses in Experiment 1.[1] A reexamination of the logical groupings reveals that some of the categories probably overlapped and could have been combined. For example, main ideas, analogy, and personal experience might have been combined. Rehearsal and covert practice could have been combined for a second group. Since mnemonic strategies often utilize imaging techniques, the imaging/pictorial group could have been included in this category. These three combined groupings would be more in line with the factor analytic results.

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[1]A 2(test type) x 25(strategy) analysis, not reported in Experiment 1 data, resulted in the same ($p < .001$) significant strategy main effect and strategy x test type interaction. Results reported earlier were thus not an artifact of the way items were combined into groups.

Table 6

Principal Factors Orthogonal Rotation

	Loadings on Factors Factor A	B	C	h^2
Factor A: Overt Practice				
2. Write facts down on paper	.78	.10	.002	.61
4. Draw pictures or cartoons	.29	-.16	.05	.11
9. Make notes	.81	.02	.15	.68
10. Write summary	.25	.15	.02	.09
11. List major words/ideas	.57	.40	.07	.49
20. Picture events relating items	.17	.002	.15	.05
Factor B: Clustering Strategies				
1. Rehearsal	.16	.21	.09	.08
3. Test yourself	.10	.23	.14	.08
5. Create mental image	-.27	.22	.06	.13
6. Picture relationships	-.08	.29	.16	.11
8. Picture in locations (loci)	.11	.35	.22	.18
12. Ask yourself questions	.02	.29	.16	.11
14. Select out main ideas	.34	.53	.01	.40
15. Select out key ideas	.21	.52	.30	.40
17. Think about purpose for material	.01	.40	-.01	.16
18. Relate material to own experience	-.00	.41	.27	.24
19. Logical relations among items	-.13	.51	.07	.28
21. Picture main ideas	-.01	.39	-.07	.16
23. Learn key words/ideas in groups	.21	.32	.12	.16
Factor C: Mnemonic Strategies				
7. Emotional reactions to images	-.08	-.00	.39	.16
13. Create an outline	.10	.11	.12	.04
16. Select out action words	.20	.14	.56	.38
22. Use only 1st letters to rem. imp. words	.16	.08	.59	.38
24. Use similar letters to rem. imp. words	.11	.13	.58	.37
25. Use similar sounds to rem. imp. words	-.14	.33	.46	.34

Rosch and Lloyd (1978) have suggested that humans naturally classify objects as a means of ordering their environment. From this viewpoint, the fact that the clustering strategies factor had the greatest number of items loading on it

is both theoretically and intuitively pleasing. It seems entirely reasonable that learners attempt in some way to group ideas and facts in order to learn them more easily. The short-term memory literature (e.g., Miller, 1956) also suggests that humans retain information better when it is "chunked." On the other hand, Kerlinger (1973) points out that "a factor analysis...cannot produce factors that are not in the items" (p. 689). An alternative explanation, then, is that more items addressed this area.

The other two factors produced also have bases in the literature. Higbee (1979) has described the history of mnemonics and the utility of investigating the practical applications of such strategies to education. Overt practice techniques, such as notetaking (Carrier & Titus, 1981; Rickards, 1979), drawing pictures (Rasco, Tennyson, & Boutwell, 1975), and summarizing (DiVesta & Gray, 1972; Doctorow, Wittrock, & Marks, 1978) have also been investigated. In general, such strategies improved performance on posttest measures.

Summary and Conclusions

Results of the two experiments discussed here support the hypothesis that achievement is dependent not only on content and optimal design of instructional packages, but also on the cognitive strategies students use in encoding, retaining, and retrieving information contained in such packages. More specifically, a significant test type x strategy interaction supported the hypothesis that students use different strategies depending on task/test demands.

Investigations of the type undertaken here have both theoretical and practical implications. On a practical level, a descriptive model of effective learner strategies would provide empirical evidence for the building of prescriptive models for strategy training. Before a useful descriptive model

for this purpose is completed, however, further work is needed to determine what strategies correlate with superior performance in the light of particular task demands. If strategies prove to be effective across tasks, a more general model might be built. The present investigation did not address these questions.

A descriptive model of cognitive strategies used in learning situations is also a necessary first step in the development of a theory of instruction. Research on how learners process information in instructional settings has lagged far behind research on improving the quality and richness of insructional materials.

Important questions which need to be addressed in further research are: (1) Which learning strategies are most effective in terms of performance in particular task situations? (2) Are the same or different strategies effective across tasks? Evidence on the first two questions will lead to prescriptive questions such as: (1) Can less able students be trained to use more effective strategies to improve their performance on specific tasks? (2) Are there more general strategies which can be trained to improve performance across tasks? Much exciting work is already being undertaken in these areas, and the next decade promises to be a fruitful one for educational research.

Reference Notes

1. Schulte, A. C., & Weinstein, C. E. Inventories to assess cognitive learning strategies. Paper presented at the AERA annual meeting, Los Angeles, April, 1981.

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